partnership opportunity

NASA Langley's

Multi-Component, Multi-Point Interferometric Rayleigh/Mie Doppler Velocimeter

Large area, direct view flow analysis without particle-seeded flows

NASA Langley has a new technique for analyzing velocity components, temperature, and density of supersonic and hypersonic aerodynamic and combustion flows. By combining a unique direct view, signal-enhanced interferometric system with Rayleigh scattering detection, the NASA velocimeter can instantaneously measure two orthogonal flow velocity components with high temporal and spatial resolution. By detecting the Doppler shift of Rayleigh effects within the flow, the NASA approach—unlike commercial Doppler velocimetry systems—does not require particle seeding, enabling a simpler and improved measurement. The developmental and patent pending velocimetry system has been successfully demonstrated in a variety of prototype and advanced working systems in laboratory and wind tunnel facilities.

Benefits

- Novel interferometric Rayleigh scattering system architecture for large volume orthogonal velocity component flow measurements
- Widely proven Rayleigh scattering approach eliminates need for seeding flow with particles that can adversely affect flow and composition measurement accuracy
- Instantaneous multi-component flow velocities with very high spatial (~ 0.2 millimeter^3) and temporal (40 nanosecond) resolution
- Optical re-circulating subsystem recaptures scattered light and effectively doubles the signal intensity measured, resulting in improved accuracy
- Can be combined with Coherent Anti-Stokes Raman Spectroscopy (CARS) to provide flow composition and temperature data
- Uniquely capable of measuring high temperature (2400 K) or low density (1/10 atmosphere) flows, ideal for jet engine combustion analysis, and supersonic to hypersonic flows

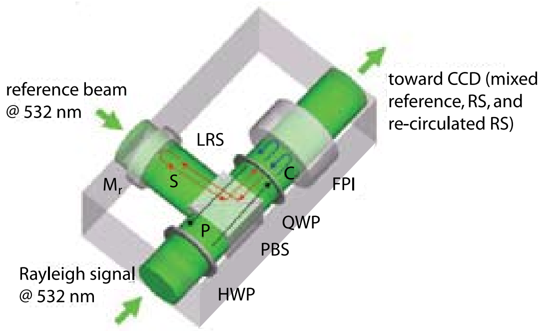

Figure 1: Novel light re-circulating sub-system for doubled signal intensity

Applications

The technology enables improved products for a variety of commercial and military applications:

- Aerodynamics – high-speed flow analysis of structures (e.g., wings, fuselage)
- Aviation – composition and flow analysis for jet engine combustion plumes
- Industrial – composition and flow analysis for gas turbine combustion
- Aerothermodynamics – quantitative measurement to characterize boundary layers in low-density hypersonic wind tunnel flows

The Technology

NASA's innovative interferometric Rayleigh scattering system was developed to enable the measurement of multiple orthogonal velocity components at several points within very high-speed or high-temperature flows. The velocity of a gaseous flow can be optically measured by sending laser light into the gas flow and then measuring the scattered light signal that is returned from matter within the flow. Scattering can arise from either gas molecules within the flow itself, known as Rayleigh scattering, or from particles within the flow, known as Mie scattering. Measuring Mie scattering is the basis of all commercial laser Doppler and particle imaging velocimetry systems, but particle seeding is problematic when measuring high-speed and high-temperature flows.

This proven NASA velocimeter is designed to measure the Doppler shift from only Rayleigh scattering, and does not require, but can also measure, particles within the flow. The system combines a direct view, large optic interferometric setup that calculates the Doppler shift from fringe patterns collected with a digital camera, and a subsystem to capture and re-circulate scattered light to maximize signal intensity. By measuring two orthogonal components of the velocity at multiple positions in the flow volume, the accuracy and usefulness of the flow measurement increases significantly over single or non-orthogonal component approaches. The subject architecture can be combined with CARS to provide temperature and composition of the measured flow. The NASA system is also uniquely capable of characterizing high velocity flames, up to 2400 K, which is very useful in analyzing high-speed combustion in fighter jet engines, scramjet engines, and even potentially gas turbines. The combined features and capabilities of the NASA interferometric Rayleigh scattering velocimeter make it a distinctively versatile and powerful flow analysis tool.

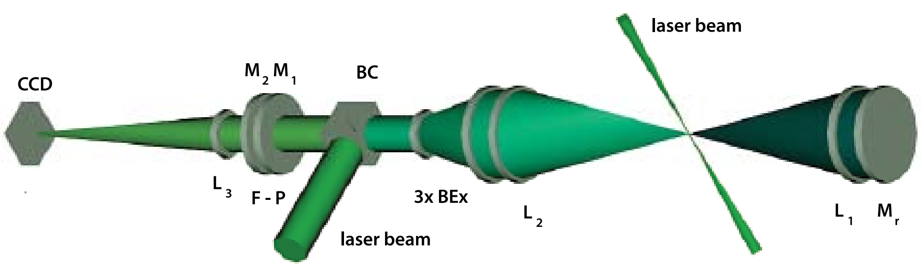

Figure 2: Large direct view interferometric Rayleigh scattering velocimetry system

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

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